Dynamic Airspace and Capacity Management DAC

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Papers & Analysis

This was a session with high quality papers. Results were presented, which can be used for sector planning and dynamic airspace usage. There is a lot of progress in this field. The overall impression is that the field of dynamic airspace usage is now maturing to a level where it can be applied in developing tools for airspace design and sector planning.

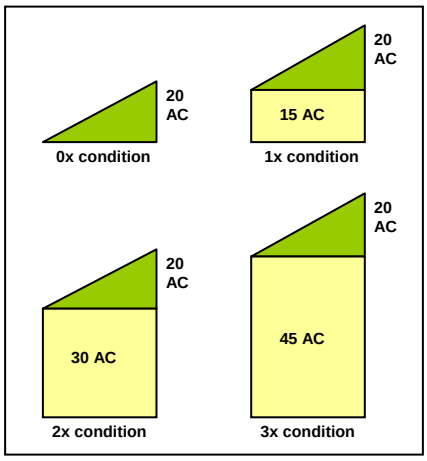
The US seems ahead of Europe on this topic, as is also reflected in the 75% US papers. This could also be due to the difference in context: in the US making this more relevant than in Europe, where one center in general has less airspace.

Summarizing it in one phrase: This session was all about how to use your airspace in different time spans: from airspace design (the first paper) till dynamic airspace usage.

Paper 89: Feasibility of Mixed Equipage Operations in the Same Airspace, presented by Paul Lee (SJSU)

This paper discussed an experiment looking into the possibility to have mixed equipage operations in one sector.

Mixed equipage was defined as follows:



Equipped aircraft are separated by ground-based automation and have:

- Data link
- FMS
- Conflict resolution uplinked via data link

Unequipped aircraft are managed by controller and have:

- No data link
- Conflict resolution via voice

The equipped aircraft were used as background traffic in scenarios where the unequipped aircraft gradually increase to a number of 20. The question now is: Until what level of traffic density (and mix) will the controller still be able to manage the traffic. The background traffic of equipped aircraft is thus only used to generate conflicts with the unequipped aircraft, varying in density from 0 to 4 times the regular density for the sector (15 aircraft). This experimental design is also illustrated by the figure.

The results suggest that mixed equipage is feasible up to a limit. In this case, this appeared to be 12 unequipped aircraft and 30 equipped aircraft.

The discussion after the presentation was mainly about what the conclusion means. Is it possible to generalize this? (Yes, says Paul Lee) Isn't this very sensitive to the choices made in the operational concept, i.e. the definitions of what the mix is and the role of the automation and the operator? (Yes, it does depend on the operational concept, but for this concept it seems possible to generalize this result for other sectors) There was also some discussion about the choice to completely automate the conflict resolution for the equipped aircraft

Paper 105: An efficient airspace configuration forecast, presented by David Gianazza (DSNA)

This presentation showed an analysis, which was translated into a tool for the FMP operator, where FMP stands for Flow Management Position. Currently the planned sectors and the actual number of sectors used over a day often do not match as can be seen in the example in figure 1 (left).

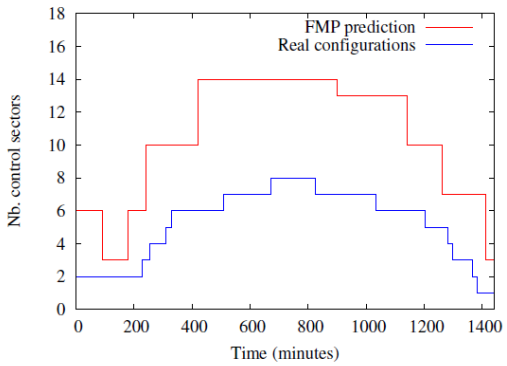


Fig. 1. Number of control sectors (FMP prediction and actual sector configurations) in Brest ACC, june 2003 the 2nd.

The idea of the paper was to make a better prediction of the controllers' workload and thus the number of sectors needed.

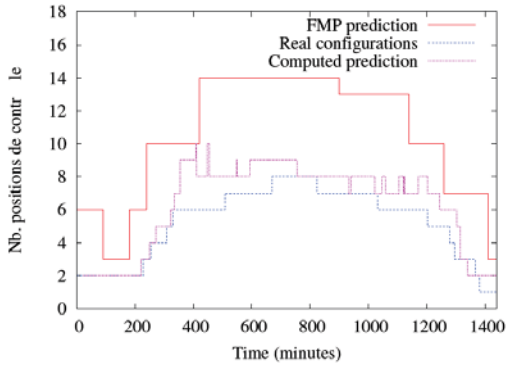


Fig. 5. Number of control sectors (FMP prediction, computed prediction, and actual sector configurations) in Brest ACC, june 2003 the 2nd.

Earlier work showed a link of 6 factors to the experienced workload by the controller. These 6 factors were:

- the sector volume *V*
- the number of aircraft within the sector *Nb*,
- the average vertical speed *avg_vs*
- the incoming flow with a time horizons of 15 minutes, F_{15}
- the incoming flow with a time horizons of 60 minutes F_{60}
- the number of potential trajectory crossings with anangle greater than 20 degrees (*inter_hori*)

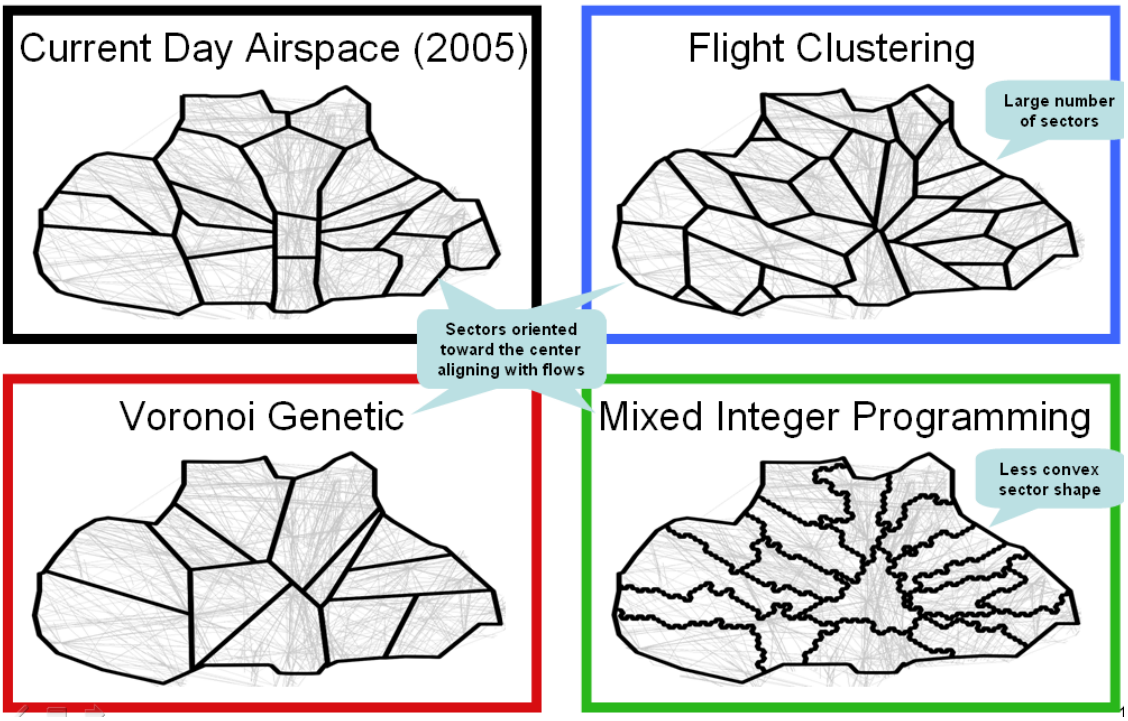
A neural network and a lot of traffic samples for different sectors were used to 'learn' the correlation between these factors and the required number of sectors. The result, after smoothing, is a predicted number of sectors that matches the reality much better (see figure 5).

The following discussion was mainly on the assumptions for the workload estimation. Why the 6 parameters? Were emergencies included? (No.) Why was the originally planned number of sectors so much higher? Were the planners maybe including a safety buffer and not making an estimation error? (Was not investigated, but may be checked later.)

Paper 85: A Comparison of Algorithm Generated Sectorizations, presented by Shannon Zelinski (NASA Ames)

Shannon presented a comparison of three different algorithms that use the flight plans to generate a proposed sectorization and compared this also with today's sector layout.

The three algorithms were: Flight Clustering, Voronoi Genetic and Mixed Integer Programming (using hex cells). Even though there was some difference in criteria and method, in the end they all tried to achieve the same goal: manageable sectors and high throughput. Still, the results appear to be very different:



The differences were discussed. Also, Voronoi Genetic does the best job of increasing system efficiency with minimal decrease in number of sectors compared to current day.

The following Q&A was mainly on how these huge differences can be explained.

Paper 128: Optimizing Airspace Sectors for Varying Demand Patterns using Multi-Controller Staffing, presented by Shin-Lai Tien (Univ of Maryland)

The last presentation of the session was somewhat similar to the previous. It looked at a variant of mixed integer programming with the hex cells (YMIP) to design sectors and compares this with a developed Multi-Period Variable Controller (MPVC) Model. The MPVC model performs better in term of resource efficiency (ATCO hours) and aircraft dwell time for two different sectors.

The following discussion asked whether the number of resulting hand-offs were included in the analysis. (Not explicitly, but it will be efficient in terms of hand-offs because it is aligned with the traffic flows.) How does the work compare to that of Shannon Zelinski? This MIP algorithm was improved, but still both presentations prove another algorithm does a better job than mixed integer programming.

General Aspects:

There were 3 US papers and 1 European paper. The quality of papers and presentations was high. All had a high amount of actual content and data.

The number of participants was also high: more than 40 persons attended this session.

For future sessions on this topic, I expect a shift towards more tool implementation. This could be an idea to include this in the naming of the topics in the call for the next seminar.

Using half of the 45 minutes for questions seems a bit long. Also the assumption that everybody has read the paper is wrong. So more time for the presentation would be welcome, if we stick to 45 minutes. In our case, we finished early because for the last two presentations the discussion that was needed did not take 25 minutes but only 10. Another option could be to have slots of 30 minutes with 20 minutes presentation and 5-10 minutes question. Especially since on the last day, we now have more time for discussion.